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ASTRONOMY DURING THE NINETEENTH CENTURY

A Popular History of Astronomy during the Nineteenth Century. By Agnes M. Clerke. (Edinburgh: Adam and Charles Black, 1885.)

WE have read this book with very great interest and with no little pleasure. The authoress (for this learned volume is indeed the product of a lady's pen) has modestly described her "History of Astronomy" as a popular work. We certainly hope that the book will be as popular as it deserves, and that it will be widely and extensively read. We think, however, that few men of science who use this book will think that it ought to be classed as a popular work in the ordinary acceptation. It might be more correctly described as a masterly exposition of the results of modern astronomy in those departments now usually characterised as physical.

Prof. Grant's "History of Astronomy," now more than thirty years old, treated of astronomy prior to that remarkable development of the science consequent on the invention of the spectroscope; Miss Clerke may thus be said to have resumed the subject from the point which Prof. Grant reached, and her present work is well worthy of a place beside Grant's volume in every astronomical library.

In the opening pages of the introduction Miss Clerke distinguishes the three great branches of the science of astronomy. The primary branch is that known as "observational," which involves the art of observing the returns and measuring the places of the heavenly bodies, but is not concerned with schemes for harmonising these facts into a compendious theory. The second kind of astronomy is that founded by Newton, and is most appropriately termed "gravitational." It seeks to account for the main facts of astronomy, in so far as the movements of the bodies are concerned, by the operation of the law of gravitation. The third branch is that which Miss Clerke terms "physical and descriptive." This branch of astronomy embraces the detailed study of the features of the different celestial bodies, and also the examination of their actual character and chemical composition. The two first branches are the older and better-known parts of astronomy. It is in the third branch that the great developments of modern times have taken place. It is especially in this department that Miss Clerke's work will be found invaluable as giving a succinct and accurate summary of our knowledge.

The work is divided naturally into two portions. The first part describes the progress of astronomy during the first half of the nineteenth century. It opens with an account of the career of Sir W. Herschel and his discoveries. In subsequent chapters of the first part we have the account of the memorable achievements of Bessel and Struve in sidereal astronomy. We have also a useful sketch of the earlier observations on and theories with regard to the structure of the sun; the discovery of the minor planets; the development of the cometary discoveries so far as the laws of their motions are con-

cerned; and an account of the instrumental advances up to the time of the great Rosse reflector.

It is, however, in the second part, on "The Recent Progress of Astronomy," that Miss Clerke has found a new field, which she has occupied with great success. The earlier chapters of the second part relate to the foundations of astronomical physics. There is an admirable account of the state of our knowledge with respect to sunspots, and of the results obtained from recent eclipses. The spectroscopic work on the sun is discussed in an able chapter, while the researches on the great constant of the universe—the sun's distance—fitly occupy another. Then we have an account of the recent discoveries with respect to the planets and their satellites, and of the theory of planetary evolution. Chapters X. and XI., on comets, are especially good, and the spectroscopic labours on stars and nebulae are also well described. A chapter on the methods of research concludes a volume of 468 pages. The photographic and spectroscopic work is virtually the theme of this book, and any one who desires to learn what has been done by Huggins and Lockyer, or by Young, or Janssen, or Vogel, will find full and accurate information. An index is provided which might, however, have been a little more extended with advantage.

At nearly every point Miss Clerke is careful to quote the references to the original authorities: this is indeed so characteristic a feature in the work that it would be valuable for these references alone, though in saying this we do not imply the slightest disrespect to Miss Clerke's able epitome of the results of each paper she has quoted. Many years of labour must have been required for the production of this work, for Miss Clerke has evidently studied with elaborate care the original writings on each subject.

So far as we have seen Miss Clerke does not appear to have been herself an observer of the heavens, and once or twice remarks occur which would hardly have been made by one who is familiar with astronomy in its practical sense. We are told, for instance, on page 103, that Bessel when a boy, could see the components of ϵ Lyræ apart with the unaided eye; no doubt he could, but the remark would hardly have been made by one who knew that everybody with tolerable vision can do the same.

In some few places we think that it would have been better to have allowed vague old speculations to pass into oblivion than to furbish them up once again; what, for instance, is the advantage of reproducing Wright's doctrines about the Milky Way, or the astronomical theories of Kant? No astronomy is worth anything which is not grounded on accurate observation or rigid calculation. The "Central Sun" rubbish ought never to have again been printed. We have however but few criticisms to offer on a work so thorough and so carefully written. Miss Clerke has expressly disclaimed any intention of discussing the more abstract mathematical researches relating to astronomy; one of the few exceptions is to be found in a description of Prof. George Darwin's now celebrated theory of tidal evolution; the account here given is both interesting and accurate so far as it goes, but mathematicians do not like such expressions as "wasting its momentum as heat dissipated through space" (p. 316).

The literary style of Miss Clerke's work is especially

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admirable; a brief sentence is frequently found to contain an accurate and vigorous expression of an elaborate point. On page 3 we are told that "observation is the pitiless critic of theory." We are told that the probability of 61 Cygni forming a connected pair is actually greater than the chance of the sun rising to-morrow morning. We read of inconspicuous minor planets being difficult to detect "in the majestic disguise of a distant sun." We are told how Prof. Adams would not "take any steps to obtain a publicity which he was more anxious to merit than to secure." In referring to the same event, Miss Clerke describes how Lalande narrowly escaped the accidental discovery of Neptune, and adds: "An immortality which he would have been the last to despise hung in the balance; the feather-weight of his carelessness, however, kicked the beam." In speaking of the moon and the possible variations of lunar objects, Miss Clerke says: "A change always seems to the inquisitive intellect of man like a breach in the defences of Nature's secrets, through which it may hope to make its way to the citadel." There are charming bits of biography through the book: as of Olbers, who became a mathematician because he was an astronomer; of Encke, who became an astronomer because he was a mathematician; or of Schwabe, who, seeking his father's asses, found a kingdom.

There are, however, some few omissions, for which we hope in a future edition room will be made. We should have an account of Brünnow's work on stellar parallax. We think also that a history of modern researches on double-stars should include a notice of Dembowski's most elaborate observations; while the labours of Doberck deserve notice, as we owe to this indefatigable astronomer the greater part of our knowledge of the binary-star orbits. Miss Clerke has, however, fully appreciated the splendid work of S. W. Burnham, who has in ten years discovered 1000 double-stars. Those who are aware of the magnificent labours of Prof. Rowland, of Baltimore, on the solar spectrum will be disappointed in not finding some reference in a work of this kind. It must, however, be admitted that a complete account of Prof. Rowland's work has not yet been published.

Miss Clerke's most admirable work fills a widely-felt want. The progress of spectroscopy has been recently so rapid that it was often difficult to find out what was known and what was unknown. It is here that Miss Clerke renders an assistance that every astronomer must appreciate. He can in this volume obtain a vivid and accurate summary of what has been done, or, if he prefers to read the original memoirs, he will be directed where to find them. The work has been most skilfully and faithfully executed, and we heartily recommend it to every one who is interested in the noblest of the sciences.

ROBERT S. BALL

CRANIOGRAPHY

Eine exacte Methode der Craniographie. Von Dr. C. Rieger. (Jena: Verlag von G. Fischer, 1885.)

THIS work contains the description of a method of craniography employed by the author for upwards of five years for obtaining exact geometrical drawings

from the skull or from the head of the living person. The first question dealt with by the author is the plane of orientation of the skull to be adopted. He discards all those which have for their aim the placing of the skull or head in the position natural to man, namely, with the axis of vision as nearly as possible horizontal, and prefers a plane determined by anatomical considerations alone. After studying different anatomical points on the skull for this purpose, he came to the conclusion that the most suitable is a plane running along the base of the cerebrum, extending in front from the angle which the horizontal and vertical portions of the frontal bone make internally with one another to the upper border of the sulcus transversus of the occipital bone, the attachment line of the tentorium cerebelli. This plane placed horizontally is the orientation of the skull adopted by the author. He then proceeds to consider the question of how far the proposed horizontal corresponds to the base of the cerebrum; and secondly, whether it can be determined on the periphery of the unopened skull or the head of the living. Sections of the skull show that the plane corresponds fairly in front with the base of the cerebrum, but posteriorly there is an elevation of the anterior part of the cerebellum and ganglia, so that it does not follow exactly the line of the cerebellum, though roughly it may be said to do so. The determination of the points on the exterior which correspond respectively to the anterior and posterior ends of the plane or long axis of the skull is of greater importance. The anterior point is defined as that point where a line joining the upper borders of the orbits crosses the median line of the skull. The posterior point is more difficult to define, as here several anatomical questions are involved, such as the relation of the protuberantia externa to the interna, and whether the latter corresponds to a fixed point externally. From his investigations the author found that the position of the attachment of the tentorium on which the posterior end of the cerebrum rests cannot be exactly determined in the unopened head or skull, but the variations in position of the external and internal protuberances in comparison to the whole cranial space are so small that the error is infinitesimal. Both in the skull and in the living the termination externally and posteriorly of the plane may be taken as that point where the linea semicircularis superior intersects the protuberantia occipitalis externa in the middle line, or in the living immediately above the line of attachment of the muscles. Having determined these points, he proceeds to show that the outlines of the dimensions of the skull in relation to this plane can be taken only with the assistance of ordinates standing at right angles to one another. He has satisfied himself that it is necessary to have complete outlines of the whole of the curves, and not only the greatest dimensions, so that a model of the skull from which they are taken can be at once apparent. Only a few of the most important curves require to be taken in every case: these are a curve of the ground or horizontal plane, of the median plane, and a third transversely over the cranium in the plane of the external auditory meatus.

The method of obtaining the curves is as follows:—Two threads are tied in the centre so as to form a cross; each end is weighted with lead. The knot is placed in